5-2003

Recreational Use of Montane Streams of the Puerto Rican Rainforest

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RECREATIONAL USE OF MONTANE STREAMS OF THE PUERTO RICAN RAINFOREST

by

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Thesis submitted in partial fulfillment of the requirements for the degree of Environmental Studies

DEPARTMENT HONORS

in

The Department of Environment and Society

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UTAH STATE UNIVERSITY
Logan, UT

2003

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November 22, 2002

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Introduction

As the population of the small island of Puerto Rico increases, so do the number of recreationists in natural areas. With increasing pressure on finite resources, managers must understand how humans are using these resources in order to conserve without limiting visitor satisfaction.

Much of the outdoor recreation in Puerto Rico takes place in the Caribbean National Forest (CNF), known locally as El Yunque. Recent studies show that aquatic habitat may be in danger due to anthropogenic influences and alterations (Garcia and Hemphill, unpublished manuscript). The primary use of the forest's resources today is recreation, especially along rivers and streams. Another use is fishing, which is often a form of recreation. This puts stress on the aquatic system and could have potentially damaging effects on aquatic fauna.

The CNF is managed by the United States Department of Agriculture Forest Service (USDAFS). Its forested mountains, crystal streams, and close proximity to the metropolitan and urban areas make the CNF a prime location for weekend and day-use recreation. As the only tropical rainforest in the US National Forest system, it is also a popular tourist destination for both Puerto Ricans and Americans.

The Forest Service has created an extensive trail system for visitor use along highway 191, the main access road within the forest. There are designated parking areas and information stations at the trailheads; many of the trails are paved for safe and easy use. Several of these trails lead to areas where stream recreation is possible. In addition to these designated access areas, there are other locations where river access is convenient due to bridges or close proximity of the river to the road. Some other frequently visited river access sites are located just outside the CNF boundaries. These areas are under the jurisdiction of the Puerto Rican Departamento de Recursos Naturales y Ambientales (DRNA). Due to their small size and obscure locations, they receive less attention than other sites. While designated river use areas are intensely managed and maintained, these other access points are not.

Although the Forest Service and other organizations perform a wide variety of research in the forest, only two studies have accounted for human use. The first was a visitor survey conducted by a graduate student in 1986, which provided "information on

the human aspects of forest management in the CNF" (Dougherty, 1988). The second was an evaluation of "the customer" done by the Forest Service (1992). While both of these studies provided valuable information to the Forest Service, they account for a limited scope of users and impacted areas. These studies focused on access points along highway 191, which are primarily used by tourists and do not consider use in other parts of the forest or common activities of local residents.

During the summer of 2001, two visitor use studies were conducted on two rivers that run through the CNF. These studies were performed at two sites within the forest and two sites with similar characteristics that were near, but not within CNF boundaries. The purpose of the first study was to describe the basic attributes of recreationists and frequency and types of river use. The second study was an attempt to classify fishermen and their habits. In addition to the four study sites, data was collected from a other locations along the two rivers. Both studies looked at the possible effects of human use of aquatic ecosystems on aquatic fauna and results were used to make suggestions for possible management and education strategies.

Description of Study Area

The CNF is located in the northeastern corner of Puerto Rico, the most densely populated part of the island. The two rivers used in this study, the Mameyes and Espiritu Santo, originate in the Luquillo Mountains of the CNF and run through the forest and a few small towns before emptying into the Atlantic Ocean. The Mameyes River is on the east side of the forest, which is frequented by thousands of tourists each year. The Espiritu Santo is on the west side of the forest, which is not as well known.

Four sites were used in the studies, two on each river. One was a higher-elevation site inside the CNF boundaries, and the other was a lower-elevation site just outside the CNF. Three of the four sites were near bridges where a road crossed the river creating easy access for recreationists. At one site, a bend in the river was adjacent to a road, also providing easy access.

The upper site on the Mameyes was called Puente Roto, a bridge that is labeled on many maps of the forest and was the most popular of the four sites. The lower site was called the Dajao and was located just outside the forest boundaries near the small town of

Palmer on highway 191. The higher-elevation site on the Espiritu Santo was the Salto de Agua, the smallest of the four sites, found on the highway 186 running through the forest to the other side of the mountain. The lower-elevation site was called El Verde, located on the same road in the small community of El Verde.

Figure 1.1- *Map of Puerto Rico and the Caribbean National Forest (CNF) with close-up of area of study sites.*

General Recreation

Introduction

Recreation is currently the primary human use of the Caribbean National Forest (CNF) of Puerto Rico. People are naturally drawn to aquatic recreation sites, especially in the tropical climate of Puerto Rico. As the number of recreationists increases, forest managers must understand recreation trends and use this knowledge to conserve natural resources while allowing the public a quality recreation experience.

The purpose of this study was to learn more about aquatic recreation on the Mameyes and Espiritu Santo Rivers found in the tropical northeastern region of Puerto Rico. This was done by defining the basic attributes of recreationists, their activities, and attitudes. This information was then used to predict possible effects of humans on aquatic wildlife, and to give suggestions for possible improvements in education.

Methods

One hundred seventy-six surveys were conducted across the four study sites. Surveys were conducted in Spanish by the author of this paper and a native Puerto Rican. At each site the surveyors attempted to talk to at least one person in each group except when the number of recreationists was exceedingly large, in which case they spoke with as many groups as possible. The sample was not truly random; therefore the results may be biased to some degree. However, results still provide useful information about recreationists.

Surveys consisted of six short questions regarding the recreationists themselves and their use of the river. These questions included current residence, frequency and type of river use, knowledge of aquatic fauna, and opinions about environmental education. Respondents were also free to give additional comments.

In addition to the surveys, a census was taken twice a week at each site, one weekday and one weekend. Counts of people and vehicles at the site were taken at the beginning and end of a half-hour or one hour period and then averaged. People were separated into two groups—in the water and out of the water—to help determine the significance of human impacts on the aquatic system. The vehicle count was taken so

that future estimates of river users could be made by counting vehicles, a much quicker process. All research was performed during the summer months of June, July, and August.

Results were calculated using Microsoft Excel and SPSS statistical software. Calculations include descriptive statistics, frequencies, crosstabs, and chi-square tests. Qualitative information was categorized and used to support statistically significant results and to point out important factors that were not included in quantitative variables.

Results

Residence, Site, and Frequency

Recreationists surveyed in this study were divided into three groups based on place of residence: Metropolitan San Juan, Rural Near Forest, and Other. Rural areas also include many suburban neighborhoods just outside the San Juan Metropolitan area. Categories were created using the USFS classification in their 1992 survey of CNF users (1992). In this study the "Other" category was created to include people from other metropolitan areas, other rural areas, and the United States. These groups were combined due to the relative lack of respondents from those areas.

Of the 176 recreationists surveyed, 101 (57.4 %) were from the Metropolitan San Juan area, 54 (30.7%) were from rural areas near the forest, and 21 (11.9%) fell into the "Other" category. Only five people (2.8%) were currently residing in the United States, thus study results primarily represent Puerto Ricans that currently inhabit the island.

The census information (Figure 2.1) shows the distribution of recreationists at the different sites. Puente Roto was by far the most frequently visited site followed by the Dajao, El Verde, and the Salto de Agua. At all sites visitor use was highest on the weekends. Total numbers were highest in June and July and tapered in August due to weather conditions and social factors. The average number of people per car was 3.71.

Table 2.1 shows the percentage of people in the water versus those out. This information, combined with overall use data provides a good description of use at each site. At Puente Roto and El Verde the numbers were almost equal, meaning that about half of visitors were in the water and about half were out. Puente Roto had the highest total numbers, with a maximum of 490 people there one Sunday at the end of June. At

the Dajao a greater percentage of people were found in the water, probably due to calmer, shallow water that was the most easily accessible of all the sites. The number of visitors there ranged from 2 on a rainy day to 181 on the weekend. The Salto de Agua site had the highest number of people out of the water due to difficult accessibility of the channel and steep bedrock. This site also had the lowest total number of visitors due to its small size and relatively unknown location. The minimum number of visitors at all sites was between zero and seven. These lows were recorded on days of severe rainstorms.

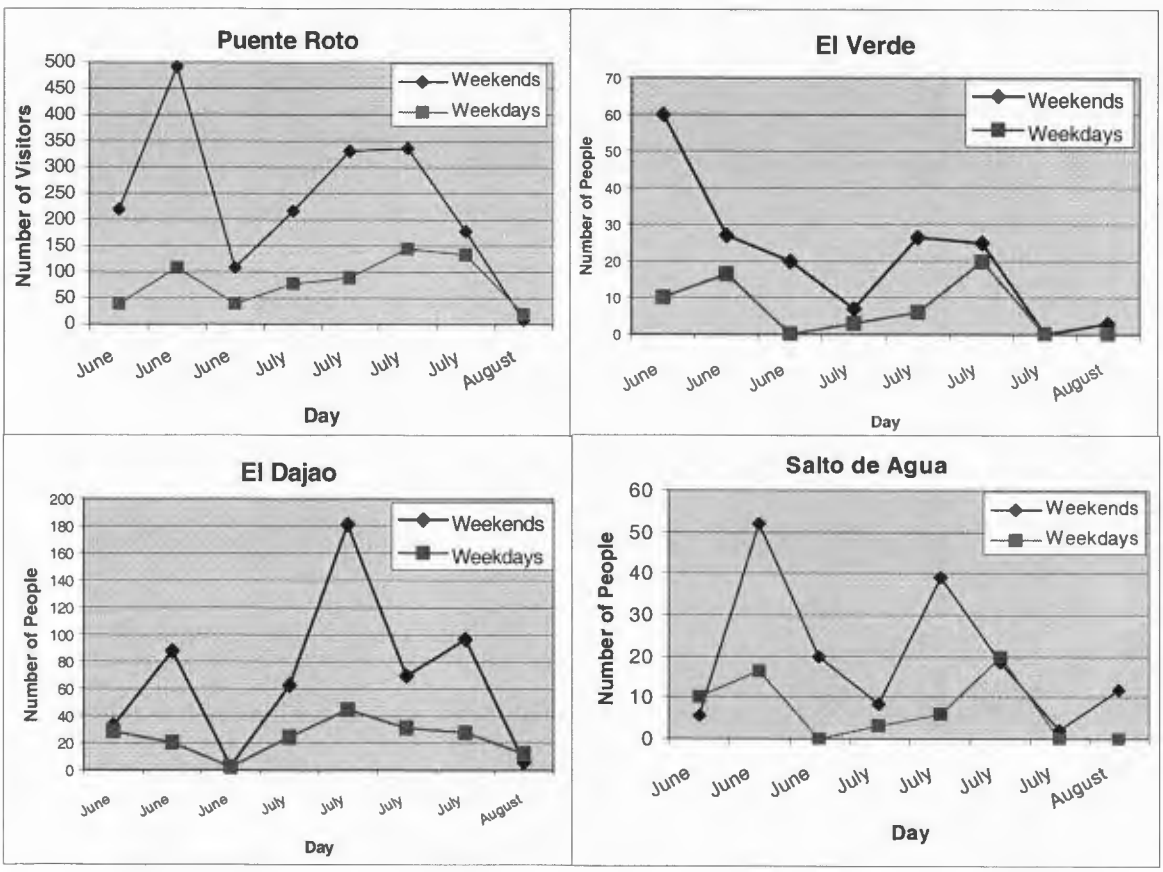


Figure 2.1- *Visitor use of recreation sites on the Mameyes and Espiritu Santo Rivers on weekends and weekdays during summer months.*

Place of residence was a determining factor in which site recreationists visited (Table 2.2). All groups had high numbers at Puente Roto, the largest and most popular site. Very few rural residents visited the Espiritu Santo sites.

People in Water vs. People out of Water		
	percent in	percent out
Puente Roto	46%	54%
El Dajao	61%	39%
El Verde	46%	54%
Salto de Agua	22%	78%

Table 2.1- *Average percentage of visitors in the water versus out of the water at each study site.*

Site vs Residence			
	Rural Near Forest	Met. San Juan	Other
Puente Roto	53.6%	45.5%	52.4%
El Dajao	38.9%	16.8%	19.0%
El Verde	5.6%	23.8%	14.3%
Salto de Agua	1.9%	13.9%	14.3%
Total	100.0%	100.0%	100.0%
Pearson's Chi Square: 20.2, p=.003			

Table 2.2- *Percentage of recreationists at each site in relation to their current residence.*

The majority of recreationists (72.7%) said they visit the river at least once a week (1-2/month or more) during the summer months (Table 2.3). Most people go 1-5 times a month (60.8%), while a small group (11.9%) goes more than five times a month. Some people in this group reported visiting the river up to four times a week during the summer. Only 8.5% said it was their first visit, and 18.8% said they go less than once a month. Residence and sampling location were not associated with the frequency of visits (chi-square: 4.8, p=.78; chi-square: 14.5, p=.27).

How often do recreationists visit the river? (June, July, and August)		
	Frequency	Percent
First time	15	8.5%
<1/month	33	18.8%
1-2/month	49	27.8%
3-5/month	58	33.0%
>5/month	21	11.9%
Total	176	100.0%

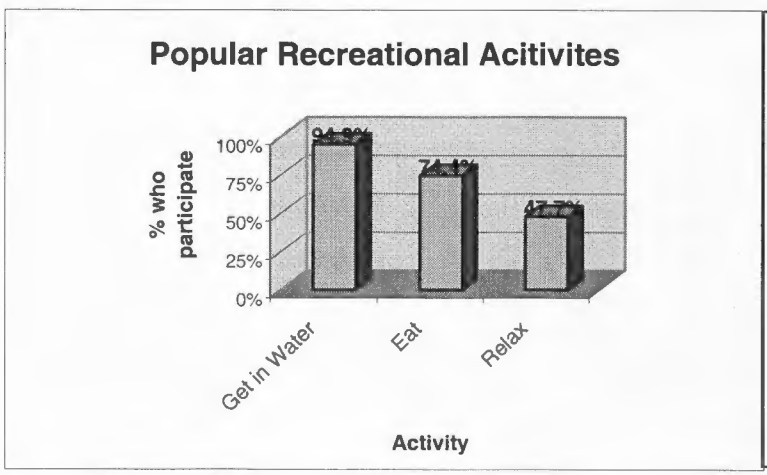
Table 2.3- *Frequency of river visitation by recreationists.*

Recreation Activities

Two questions in the survey dealt with recreational activities that people participate in at the river. First, people were specifically asked about two activities,

getting in the water and eating, which were perceived to be the most popular pastimes. They were also given the opportunity to state any other activities they thought of or were doing at the time of the survey. Just because someone did not specifically state a certain activity does not mean they do not participate in it. The results of these responses can be found in Figure 2.2.

As would be expected, almost all people surveyed said one of their primary purposes for going to the river was to get in the water (94.9%). The majority also went to eat (74.4%). Other activities include relaxing, drinking alcohol, spending time with family, playing games, enjoying nature, having fun, listening to music, cooling off and getting a massage from the river, therapy by getting out of the city, and special occasions.



Other Activities Mentioned:

- Drinking alcohol
- Spending time with family
- Playing games
- Enjoying nature
- Having fun
- Listening to music
- Cooling off
- Massage from river
- Therapy
- Special occasions

Figure 2.2- *Common recreation activities on the Mameyes and Espiritu Santo Rivers.*

The second question about activities dealt with fishing. Of the 176 people surveyed, 16 (9.1%) said that they or someone in their party fishes. While current residence did not seem to be a significant factor in whether they fished or not (chi-square: .439, p=.803), people who fish are significantly more likely to visit the rivers frequently (Table 2.4).

Fishing vs Frequency of Visitation						
	First time	<1/month	1-2/month	3-5/month	>5/month	Total
Fish	0.0%	0.0%	12.4%	56.3%	31.3%	100.0%
Don't Fish	9.4%	20.6%	29.4%	30.6%	10.0%	100.0%
Pearson's Chi-Square: 14.7, p=.005						

Table 2.4- *Percent of visitors who fish versus how often they visit the river.*

The question about fishing also elicited a notable amount of additional comments. Most of these comments were related to perceived fishing policies in these recreation areas. Many people believed that the Forest Service and DRNA prohibited fishing in these rivers, though most people did not have substantial evidence to back that belief. Some people also mentioned concern about the used of toxic chemicals like bleach to kill and capture aquatic wildlife.

Knowledge of Aquatic Fauna

There are approximately eleven species of aquatic fauna that live in the Mameyes and Espiritu Santo Rivers, including fish, shrimp, snails, and crabs. This number varies with altitude, as some species do not live at higher altitudes above large waterfalls. Recreationists were asked an open-ended question about which aquatic species they were familiar with.

Figure 2.3 shows the percentage of people who recognized each animal. The category "none" represents the people who stated that there were no animals living in the river. "Don't know" means that they knew there were animals in the river, but they didn't know what they were. The "Other" category represents people who named animals that are not found in the rivers in this study such as blue crabs and other fish species.

Few people believed in the complete absence of aquatic wildlife (2.8%), while 10.8% fell into the "don't know" category. The most commonly recognized animals were the largest, with the most well known being the large shrimp (*macrobrachium spp*, 63.6%). The only other animals that were listed by at least one-third of the people were the mountain mullet (*agonostomus monticula*, 39.8%) and the crab (*epilobocera sinuatifrons*, 33.3%). Almost a quarter of the people knew there was some type of fish in the river. The rest of the animals were relatively unknown. It is noteworthy to mention that 10.2% of people surveyed named at least one animal not actually found in these rivers.

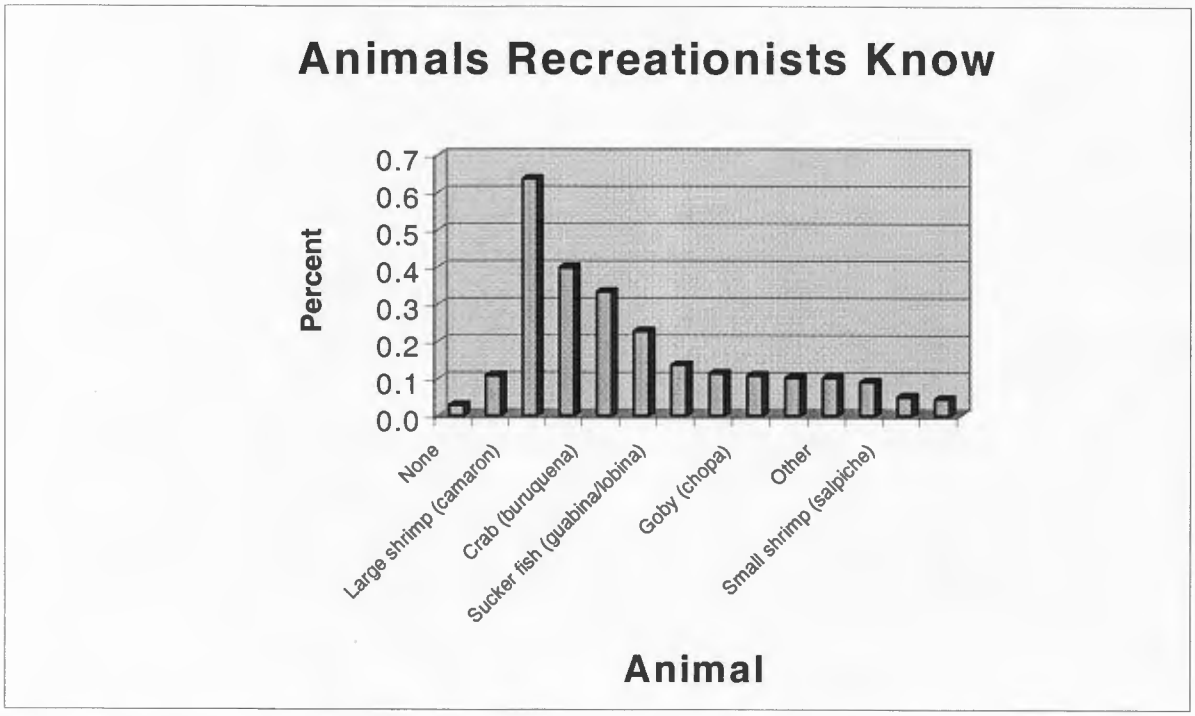


Figure2.3- *Percentage of recreationists who named each animal that lives in the rivers studied.*

There was a strong correlation between frequency of visitation and knowledge of aquatic fauna (Table 2.5). People who visited the river more often knew more about the animals that live there. No one who visited the river less than once a month knew more than three animals, while almost everyone who visited more than five times a month knew at least one animal.

Frequency of Visits vs Knowledge of Aquatic Fauna				
	no animals	**1-3 animals**	**>3 animals**	Total
First time	26.7%	73.3%	**0.0%**	100.0%
<1/month	21.2%	78.8%	**0.0%**	100.0%
1-2/month	12.2%	65.3%	22.4%	100.0%
3-5/month	13.8%	56.9%	29.3%	100.0%
>5/month	4.8%	**47.6%**	**47.6%**	100.0%
Pearson's chi-square: 25.3, p=.001				

Table 2.5- *Recreationists' knowledge of aquatic fauna based on frequency of river use.*

Education

When asked if the government should educate Puerto Ricans on how to use the rivers in a more ecological and safe manner, 98.3% agreed that this was necessary. The

1.7% who disagreed either did not care or felt that the people should take the responsibility upon themselves to be educated rather than relying on the government.

This question spurred a number of additional comments, the most common being a concern with the large amount of trash at recreation sites. One hundred fifteen people out of 179 (65.3%) said that there was too much trash along the rivers. Many felt that the government should educate the people not to litter and enforce laws that prohibit littering. Others felt that the government should be more active in cleaning the trash up. Once again the apparent use of toxic chemicals by fishermen was mentioned. Some people cited littering as an inherent cultural problem of Puerto Ricans.

Other reasons people favor increased education were the dangers of being at the river, the need for knowledge of the animals and ecology of the river system, and conservation. Of these three topics, the most frequently mentioned were the dangers of the river. Some people are unaware of the danger of flash floods during or after storms and many people who visit the rivers do not know how to swim. They feel the need for increased education in these areas in order to make the recreation experience safer and more enjoyable.

A relatively small number of people talked about the need for increased knowledge of aquatic systems, and most felt this action should be taken in public schools or training courses offered by the government. Of the people who commented on conservation, most said that they have been visiting these rivers for a number of years and they have noticed a decrease in the biota and increased degradation of the sites in question.

Discussion

These results show that the majority of river-users are inhabitants of metropolitan and suburban areas near the rivers. They go to the river with friends and family to escape the rigors of life. They tend to visit locations near their homes, and while there they participate in relaxing activities. Visitor use is high during the summer months, due to climactic and sociocultural conditions. This is the hottest time of year and people are looking for a way to cool off and relax. Children are out of school and several holidays

are celebrated during these months. Use tapers off toward the end of the summer as people return to the routine of life and violent rainstorms become more frequent.

Puente Roto is the most well known and crowded of the four sites due to its location, size, features, and representation on forest maps. Recreationists who go there are aware that they are likely to encounter large crowds, a factor that may even encourage them to choose this site. The Dajao is a calmer version of Puente Roto. The Salto de Agua is a small, unknown site in a part of the forest and receives the least use. The Espiritu Santo River passes through the town of El Verde, therefore many people have access to the river via their backyard or their neighbor's backyard. This prevents them from having to use the bridge river-access sites in order to recreate and is probably the reason rural residents made up a smaller percentage of users at this site.

The majority of river-users visit these sites one to five times a month, meaning that these people go once a week or more. A second category consists of new or low-use visitors who go to the river less than once a month or the time of this study was their first time there. These infrequent visitors sometimes reported that they were accompanying friends or were there for a special event such as a birthday or holiday. The most frequent visitors go more than five times a month, or at least once a week. These are the people who value their leisure time and recreate as often as possible. Some of them are mothers who take their children to the river to bathe and play. Some of them are friends who go to the river to drink, have fun together, and relax.

Almost everyone goes to the river to eat, cool off, and have fun with friends and family. They don't seem to care how many other people are around, and most activities are passive, like sitting in a small pool and eating while the water flows over the rocks in a massaging motion. Higher levels of activity are also possible like playing on rope swings and swimming in deeper pools. Some activities, like playing dominoes, are cultural manifestations that are taken to the river setting. Many people go to the river for special occasions showing that they value these sites even if they do not use them frequently.

The relatively low percentage of fishermen among recreationists could have several explanations. The first is that not very many people fish in these rivers. The second is that fishermen are not found in these areas with high densities of people

because it reduces the likelihood of catching anything, and fishing is more of a solitary activity. Lack of positive response to the fishing question may have also been a result of the belief that fishing in these areas is illegal. A more extensive fishing survey was conducted with people who said they fish. Those results will be discussed further in the following chapter.

Among recreationists, people who fish tend to be those who go to the river more often. This could be due to the fact that frequent visitors are more aware of the river's resources and how to use them. Another possibility is that people who spend a lot of time at the river look for a variety of activities to entertain themselves, though they do not necessarily expect to catch anything.

All recreationists who are familiar with any animals of the river recognize the largest aquatic fauna with the greatest ease. These animals are the most visible and easiest to remember. People who visit the river more often are more familiar with aquatic fauna. Some people may not have mentioned the smaller animals, like the snails, because they do not think of them as aquatic wildlife or because they do not know that they exist. Of the animals named that do not live in these rivers, the majority are found in other parts of Puerto Rico. People who named those were probably naming any aquatic wildlife they are familiar with and may not have been sure exactly which ones lived at that particular site.

With regards to ecological and safety problems, most recreationists seemed more concerned with safety issues and aesthetics than with the ecological quality of the aquatic environment. They want the safest and most enjoyable recreation experience possible in the beauty that surrounds them; most do not concern themselves with how this environment is sustained. Comments on the dangers of flash floods and not knowing how to swim are valid concerns for people spending time in aquatic areas. The expressed need for easier river access and more facilities reflects the desire for a park-like recreation experience and not an exploration of the wilderness.

Trash was cited mainly as an aesthetic problem, and not for possible effects on the environment. Most people blamed others for the trash problem and expect others, in particular the government, to remedy the problem. People agreed with the need for increased ecological education, although it is unclear whether or not this was a result of

the way the question was presented. Few people mentioned nature or the aquatic system when asked what they do at the river. The lack of knowledge of the majority of aquatic species suggests a need for increased education in this area and the overall positive response of recreationists in favor of education is encouraging.

Comparisons with Hispanic Recreation in the United States

While little research has been done concerning outdoor recreation in Puerto Rico and the Caribbean, a substantial number of studies have been conducted in the United States regarding ethnicity and recreation habits. The majority of these studies have taken place in the Southwest/California and Chicago, places where large Hispanic populations exist including Mexicans, Central and South Americans, and people from the Caribbean. The most common finding is that Hispanics are more likely than Anglos to visit natural areas to spend time with large groups of family and friends.

Irwin et al (1990) found that Mexican-Americans at a campground in New Mexico tended to have larger party sizes and were closer together than Anglos. This study also found that Mexican-Americans appreciated campground facilities and more highly developed areas than Anglos. Both of these findings denoted special subcultures that management should be aware of.

Two studies point out an increasing trend of recreation near urban areas (Carr and Williams 1993, Baas et al 1993). The purpose of this type of recreation is to get away from the pressures of life without having to travel long distances. In his study of urban parks in Chicago, Hutchinson (1987) found that Hispanic groups participated in more stationary activities than Anglos and Blacks. They also tended to have larger group sizes and participated in more group activities. Another study of parks in Chicago found that Hispanic recreationists were more likely to stay on trails in large groups of mixed ages than other ethnic groups. They also spent more time picnicking and watching soccer games (Gobster 1991).

This recreation study conducted in Puerto Rico encountered parallels to all of these studies. Recreation areas were near metropolitan and suburban areas and were frequented by people from these areas for easy day-use access. At all sites in the study, the majority of recreationists were found in large groups that were close together. Up to

490 people were encountered on one small stretch of river surrounding a bridge, while miles of river lay virtually unvisited. Most people participated in activities that did not require leaving a relatively small area and in many cases the recreationists were stationary. People cited the need for more structured walkways for easy access to popular areas and more facilities for easier use of these areas.

Education and Management

Because recreationists along the montane streams of the Puerto Rican rainforest are primarily people from metropolitan and suburban areas seeking a park-like experience, they are often unaware of the ecosystem they are affecting. People seem to have a general interest in learning more about the environment and many understand the need for this type of knowledge. The questions that remain are 1) What would be the most useful knowledge for these people to have?; and 2) Who is going to provide this education?

Currently the USFS is actively involved in the management of the Mameyes and Espiritu Santo Rivers. The extension of an American agency into the Caribbean has provided valuable resources and technology that would not have been available otherwise. However, resource managers must keep in mind the differences in resource management strategies based on cultural distinctions in Puerto Rico.

In the CNF, the majority of management efforts focus on the areas developed for tourists along highway 191. However, the sites surveyed in this study are better described as getaways for local Puerto Ricans rather than tourist destinations. Education efforts in the CNF are based at El Portal, the Forest Service visitor's center. This is an excellent facility that is visited by thousands of people each year; however, these efforts are not reaching a certain vital portion of forest-users.

Because the Dajao and El Verde sites are located outside the CNF boundaries, they are under the care of the Departamento de Recursos Naturles y Ambientales (DRNA) and not the USFS. The DRNA is responsible for numerous forest and natural reserves and wildlife refuges throughout the island. This agency is responsible for the management of all the natural resources of the island, including many marine sites. This

is a large job for one agency and does not leave time or money for small-scale monitoring and maintenance like river crossings in small towns.

Since it is unlikely that these two agencies will make an effort to work with recreationists on a community level, a local effort could be an effective approach to increase education. The most likely place to start would be in public schools in the communities where the majority of these recreationists come from. Education about the natural areas of Puerto Rico usually focuses on popular or endangered species like the coqui tree frogs and the Puerto Rican parrot. In the case of recreationists on the rivers, user-groups must be targeted and educated on a more comprehensive level. Children should be taught about the aquatic ecosystem and its importance with relation to clean water and beauty. They should also be taught safety tips for using natural areas. They could also be taken on field trips to some of these sites.

Litter seemed to be the primary concern of the recreationists surveyed. Addressing this issue might be a good way to catch the attention of the most people. This could be done through an educational sign at the sites with the highest use. This would be an easy and efficient way to inform a large number of people. The sign would present information about the effects of littering on the environment and the recreation experience. This would include effects of trash and harmful chemicals on aquatic wildlife, and the decreased satisfaction of recreation caused by an unclean environment. Another way to reinforce the negative impacts of trash would be for Forest Service personnel to enforce existing policies that can fine people up to $1000 for littering on Forest Service land like Puente Roto.

Accessibility of Forest Service and DRNA personnel to the public would clear up misconceptions that recreationists have and would increase environmental awareness. For example, the Forest Service discourages fishing and lets the people think that it is illegal. This may be the cause of unsafe fishing practices that are having negative impacts on the aquatic ecosystem. If the Forest Service educated the people about actual policies and gave tips for safer, sustainable fishing, these problems might be alleviated or avoided.

Finally, recreationists are found in large groups that are close together and they want safer, easier access to few areas. River managers could take advantage of this

situation by providing access ramps to these areas and picnic facilities. This would prevent erosion and degradation of riparian vegetation. It would also encourage use in these areas, which could protect other areas.

Conclusion

Recreation along the Mameyes and Espiritu Santo Rivers is not solely a tourist activity. Members of local communities and the San Juan Metropolitan area are the main users of aquatic recreation sites where access to these rivers is close to a road. These recreationists go to the river to relax and have fun with large groups of family and friends during the hot summer months. Their primary activities are getting in the water and eating.

These people have a limited knowledge of the aquatic fauna of the areas they recreate in and indicate a desire for increased education of ecological and safety issues associated with the river. The governing agencies of these areas, the USFS and Puerto Rican DRNA, have not focused on this particular population of river-users. In order to increase awareness of environmental issues and protect aquatic fauna, education efforts should be undertaken locally in the communities where these recreationists live. Also, public policy and regulations concerning river use should be more readily available to the people at these sites.

In order to more fully understand the recreating public, a more extensive study should be conducted over a longer time period. The fact that people are concentrated in small areas should make this style of recreation relatively easy to manage for on the condition that managers keep in mind the social and cultural attributes of recreationists.

Fishing

Introduction

The montane streams and rivers of the Caribbean National Forest (CNF) Rainforest in northeastern Puerto Rico are prime recreation sites for a growing number of people. Increased use leads to a need to understand how humans are affecting aquatic animal populations. Fishing and shrimping are two such uses that have the potential to affect stream ecosystems. As forest use increases, it is unclear whether or not aquatic wildlife extraction also rising or who might be participating in this activity.

Extensive research has been conducted on the life history, habits, population dynamics, and effects of natural disturbances on aquatic fauna in the CNF, especially decapod crustaceans (Covich et al 1996, Covich et al 1999, Crowl et al 2001). However, human impacts on these animals remain largely unknown. Understanding fishing and shrimping habits can help us more fully understand the effects of human use of rivers on aquatic ecosystems. This study was performed in order to describe the fishermen populations on the Mameyes and Espiritu Santo Rivers, what they catch, what they do with it, and their motivations for fishing. This information can provide insights to possible impacts on the aquatic ecosystem, and possibilities for improved management and education.

Methods

Twenty-five interviews were conducted by the author of this paper and a native Puerto Rican between June and August 2001. Interviews took place at four sites along the Mameyes and Espiritu Santo rivers. In addition to these sites, fishermen were encountered on the Sonadora, a tributary of the Espiritu Santo, and by word-of-mouth. The people interviewed were local community members and anyone else found fishing along any reach of these streams during this time period. All were native Puerto Ricans. Due to the wide distribution of fishermen and the lack of knowledge of fishing habits, truly random sampling would have produced insufficient results. However, these interviews provide valuable information that can be used to better understand river use and to aid in management.

The interviews consisted of nineteen questions including a fisherman description, fishing habits, and biological knowledge of the river system. Also included in the data analysis are four partial interviews of fishermen and four interviews with Forest Service management personnel. The Results section refers to the twenty-five complete interviews and four partial interviews with information from the latter included where available. Forest Service interviews are discussed in the section concerning current fishing regulations. For the purposes of this paper, the term fishing will be used to include all aquatic animal extraction including, but not limited to fishing, shrimping, and snail capturing.

Results

The Fishermen

The majority of fishermen on the Espiritu Santo and Mameyes can be classified as adult Puerto Rican males. Twenty-eight of the twenty-nine people interviewed were males and ages ranged from 15 to 75. Average age was 40.52 and median age was 37. Nineteen of the interviewees said that their family has a history of fishing. This means that their fathers, grandfathers, uncles and/or other relatives fish(ed) in Puerto Rico and passed this tradition on.

Following classifications used by the USDAFS in a 1992 survey of CNF users, geographic origin of fishermen was placed in to four categories: San Juan Metropolitan Area, Other Metropolitan Area, and Other. The Other category includes fishermen from other metropolitan and rural areas. These categories were combined due to the lack of responses in either category. Results of fishermen origin are found in Table 2.1. Eight of these people grew up somewhere other than their current residence, six in other parts of Puerto Rico and two in the United States. All but three lived at their current residence for eleven years or longer.

Fishermen According to Residence		
San Juan Metropolitan Area	9	.31
Rural Area Near Forest	15	.52
Other	5	.17
Total	29	1

Table 3.1- *Current residence of people found fishing along the Mameyes and Espiritu Santo Rivers.*

Frequency and Location

Answers to the open-ended question "How often do you fish?" varied in units so all answers were converted to fishing trips per month for comparison (Table 2.2). In order to determine how much fishing actually occurs in these rivers, fishermen were also divided into categories of those who fish throughout the year and those who fish only during the summer (three months, usually May, June, and July). Fishing varies according to when a person perceives is the best time to catch a particular animal.

Fishing Frequency					
Frequency (per month)	**First time**	**1-2**	**3-5**	**>5**	**Total**
Year Round	2	7	3	4	16
Summer Only (3 mos.)		8	1	0	9

Table 3.2- *Number of individuals and average number of times per month that they fish.*

Of the twenty-nine people interviewed, ten said they fish only in the Espiritu Santo, five fish only in the Mameyes and fourteen fish in both. Fifteen people also stated that they fish in other rivers that were not mentioned or in the ocean. Fishermen on the Mameyes and Espiritu Santo Rivers usually begin a fishing trip near a bridge or anywhere a road crosses the river or one of its tributaries. The serious fishermen then make their way upstream and cover a mile of river or more in one trip. Some go at night to avoid crowds of recreationists or to take advantage of what they believe to be better fishing conditions due to climate or the position of the moon. They like to be alone or in small groups of two to four. One fisherman said that when he goes fishing he walks far distances along the river and likes to be alone while he does it because that is his opportunity to find peace in nature.

What Fishermen Catch

Knowing how many fishermen look for each aquatic species is crucial to understanding possible effects of fishing on aquatic wildlife. Figure 3.1 shows aquatic species that fishermen seek in the Mameyes and Espiritu Santo rivers and the percent of fishermen who catch them. Almost all fishermen look for the large shrimp (*macrobrachium spp*). These shrimp present the biggest challenge to the fisherman and also provide the most meat. Crabs (*epilobocera sinuatifrons*) are the next most sought

after animal, but are much less commonly seen and are therefore caught in smaller quantities. These may also be caught by default when fishermen are looking for large shrimp because many of the methods for catching the shrimp and crabs are the same.

The only fish that grows large enough to be eaten is the mountain mullet (*agonosomous monticula*), which is the most popular catch after large shrimp and crabs. The remaining aquatic wildlife are caught less frequency. Small and medium shrimp (*xiphocaris elongata* and *atya spp*) are less desirable because most people do not eat them and catching them is not as easy or exciting as with the larger animals. Eel are relatively large, but are not seen very often and are very difficult to catch so most fishermen tend not to pursue them, although if they come across one most fishermen will try to catch it. Twenty-four percent said they catch some fish other than the mullet.

Only five people (17%) were found to catch and eat one of the snail species (*neritina punctulata*). Since they are incredibly slow-moving creatures there is little effort involved in the catch and non-fishermen have been observed collecting cans of snails, therefore it is unclear how much snail extraction actually occurs in relation to other aquatic species. The majority of fishermen said they eat what they catch (90%) and only one fishermen said he sells some of what he catches. About half (48%) said that they throw back or do not catch small shrimp, and one person said he sometimes gives large shrimp away.

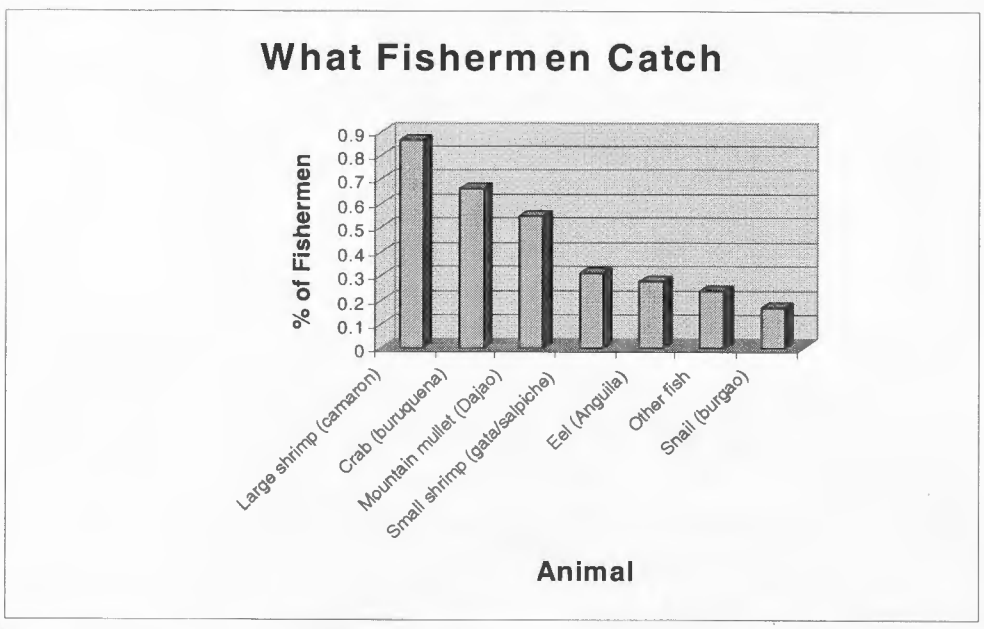


Figure 3.1- *Aquatic species and the percentage of fishermen who look for each animal.*

Motivation

The majority of people surveyed fish for fun or as a hobby and the resulting catch is a special meal for them. Many go out without expecting to catch a large amount of fish, shrimp, or other animals. This is why few fishermen fish for a regular food supply and only one person claimed to sell any of his catch. Other reasons for fishing include learning more about nature, measuring skill as a fisherman, therapy or relaxation, and tradition.

Among the fifteen people who said they fish in the ocean or in rivers other than the Espiritu Santo and Mameyes, many said that they go to those places when they are more concerned about obtaining a large catch. There are bigger and more aquatic wildlife in the ocean and in some of the larger rivers such as the Loiza. Visits to the Espiritu Santo and Mameyes rivers fulfill different expectations.

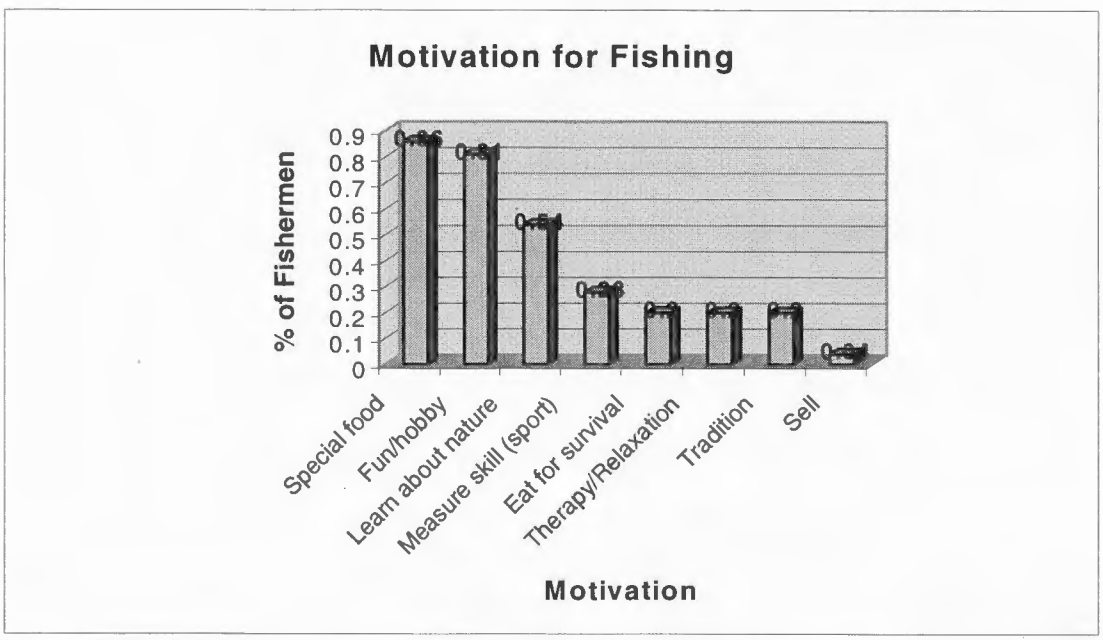


Figure 3.2- *Reasons for fishing in the Espiritu Santo and Mameyes rivers and the percent of fishermen who stated each reason.*

Fishing Methods

A complete list of fishing methods encountered and/or described in interviews, the resulting catch, and when the method can be used is found in Table 3.3. The method describes what type of tool and/or activity the fisherman uses to catch an animal. The

second column lists all of the animals that can potentially be caught using each method. The last column indicates whether each method is traditionally used during the day or at night. Each fisherman may use more than one method.

Fishing Methods		
Method	**Catch**	**When**
Hand, arm	Large shrimp, crab, burgao (snail)	Day
Trap	Large and small shrimp (depending on trap size), crab	Set at night, pick up in day
Branch (with chicken guts)	Large shrimp, crab	Day
Hook and line	Mountain mullet (with cheetos), other fish, large shrimp, eel	Day
Fishing pole	Mountain mullet, other fish	Day
Naza (pole with large net on the end)	Large and small shrimp, fish, crab, eel	Day and night
Taralla (large net)	Large and small shrimp, fish, crab, eel	Day and night
Gig	Large shrimp	Day and night
Spear	Large shrimp	Day and night (with snorkel mask)
Spear gun	Large shrimp	Day (with snorkel) and night (with snorkel)
Bamboo trap (ancient method)	Fish	?
Poison (chlorox, pesticides, etc)	Kills everything	Day

Table 3.3- *Summary of fishing methods, including animals that can be caught using each method, and time of day that the method is used.*

The most popular methods of fishing are hook and line and nets. These methods are most commonly used to catch the mountain mullet, crabs, and large shrimp, which are the animals most fishermen look for. Almost everyone who catches smaller shrimp uses traps, but since fewer fishermen pursue small shrimp, fewer overall use this method. Traps can also be used to catch large shrimp and crabs, however fewer people know about this method. Of the fishermen who stated hands or arms as a fishing method, many were recreationists who were not at the river for the sole purpose of fishing and therefore did not have any other means of catching anything. Others were fishermen with additional equipment who used their hands and arms instead when that was most effective. Only the most experienced fishermen use spears, spear guns, and gigs.

Fishing methods play a large role in determining the type of fisherman a person is. Popularity and use of different methods correlate with intentions and expectations. Few people use traps because they are unaware of this method or because they want a different type of experience. People fish as a social activity want to be out on the river for an extended period of time, and traps are simply set in the water and left for a few hours or until the next day. Some people were observed with fishing poles on stretches of the rivers that are high in elevation and there are no fish large enough to catch using this method. These people would be considered very casual recreation fishermen and probably do not catch much.

Though no one claimed to fish by putting toxic chemicals such as Clorox in the river, 79% of the fishermen interviewed had either heard of or seen the effects of poisoning events in these rivers. Eighty-five percent said they understand the damaging effects of these actions on the aquatic system. Poisoning kills everything in the immediate vicinity of the chemicals and can have more extensive negative impacts depending on the quantity of chemicals released into the water. Most fishermen agreed that this is an unsafe fishing method, though it is still unclear how many people actually participate in these activities.

Biological Knowledge

With very few exceptions, fishermen recognize that there is some diversity among fish and shrimp species living in the Espiritu Santo and Mameyes rivers. Only five people stated that there was no shrimp diversity (one or fewer species) and one said he didn't know. This means that 76% of fishermen knew that there were at least two different types of shrimp living in the rivers. Also on a positive note, 88% of fishermen said they recognize gravid female shrimp. However, only 38% said they knew that the shrimp were diadromous. This is an important factor to consider since shrimp migration is an important part of the reproductive cycle and fishermen could have a negative effect on populations if they do not know this.

Education and Government Control

Fishermen were asked a question about education similar to that in the recreation survey. They were asked whether or not the government should educate people about how to fish more safely and ecologically. Like recreationists, the favorable response rate was high with 96% of fishermen agreeing that increased education is necessary. However, fishermen also voiced concern for the way that the government is managing these rivers.

When asked whether or not the government should control fishing by requiring licenses, limits on allowable catches, or some other form of regulation, 41% agreed, while 59% said no. Some fishermen say that licenses would not be effective because management agencies would have to pay for enforcement, and that money would be better used for increased education. Others say that people should not be limited in the amount of resources they are allowed to use. Those in favor of more government control are worried that shrimp and fish populations are declining and that this might be the only way to ensure healthy populations in the future. Almost everyone agreed that the government should prevent poisoning events in the rivers.

The most common comment by fishermen was that there used to be more large shrimp and fish in these rivers than there are now. This comment increased in importance when given by fishermen who have been using these rivers for many years and whose fathers or uncles fished for years before them.

Current Fishing Regulations

Although people have been extracting wildlife from the streams and rivers of the CNF for centuries, a scientific assessment of aquatic wildlife was not made until the mid-1980s by the research branch of the Forest Service. Contrary to popular belief, fishing within national forest boundaries is not illegal, although it is not encouraged. On the Forest Service website (www.southernregion.fs.fed.us/caribbean/index.htm) under "Recreation: Fishing" it states "Due to this unique environment and our goal to maintain the ecosystem process, we ask that no fishing be allowed on the Caribbean National Forest."

Some Forest Service employees believe that fishing in the forest causes ecological damage. For example, it is believed that many fishermen catch and keep gravid female shrimp and crabs on a regular basis. Also, the streams are relatively small, therefore a very small portion of the aquatic wildlife is large enough for people to catch and eat. If a large number of people are extracting a relatively small number of large aquatic wildlife, there is great potential for population decimation.

Another problem the Forest Service must deal with in regards to the health of aquatic wildlife is the poisoning of rivers. Some monitoring of shrimp recovery rates after a poisoning event in one reach of the Sonadora tributary has been done, but the long-term effects of poisoning on the aquatic ecosystems is still largely unknown (E. Greathouse, personal communication). Insufficient funding for monitoring or enforcement of existing policies when the effects of such actions are unclear also presents a problem. One member of the Forest Service management team described a policy that allows forest visitors a designated quantity of forest goods each year, including fish, shrimp, etc., and that after taking their allotted quantity they must pay a fee. No published evidence or verification by other Forest Service employees of this policy was obtained and no enforcement is currently taking place. In general, there is no monitoring of fishing within the CNF by the Forest Service.

As stated in the previous chapter, the other managing agency of these rivers, the Puerto Rican Departamento de Recursos Naturales y Ambientales (DRNA), has little impact on a local scale. This agency deals with natural resource management throughout the island on a large scale and does not have the resources to deal with small-scale problems.

Discussion

The typical fisherman in the study area is a middle-aged Puerto Rican male who lives near the place where he fishes. The majority of fishermen grew up in or near the region of the forest and learned to fish from a friend or family member. Frequency of fishing trips varies greatly from person to person. No one depends on the food they catch for subsistence; therefore there were no fishermen who were obligated to fish frequently or on a regular basis. The group of fishermen that fishes most often is relatively small.

Fishermen like to go out and have a good time and try to catch enough food for a special meal. In general, fishermen know that there is some aquatic species diversity and they use different methods depending on what they want to catch. They believe that the government should educate people about safe and ecological fishing practices, but opinions concerning actual government regulation are divided.

Two types of fishermen

Fishermen can be placed into two general categories: the recreation fisherman and the serious fisherman. These categories represent the extremes on opposite ends of a continuum. Individuals vary along the continuum. The majority of fishermen surveyed in this study would most likely be found on the recreation end of the continuum.

The recreation fisherman fishes as a hobby. He enjoys going out into nature, cooling off, and relaxing. He does not always go to the river for the sole purpose of fishing, and often his fishing techniques are not as refined as the serious fisherman. For this reason he most likely does not catch as many animals and does not depend on them as a food resource. He is more likely to fish during the day when there are other people around and can often be found at the river with friends and family.

The serious fisherman is usually someone who grew up near the area where he fishes. He has family members who fish or have a history of fishing and he knows the refined techniques of fishing. His ecological knowledge is higher than that of the recreational fisherman. While he enjoys being close to nature, the serious fisherman does not fish just to get out of the house, but because of tradition, for the food value, or for other more personal reasons. He desires solitude or the company of a few close friends or family members. He is very familiar with his surroundings and is more difficult to locate. The serious fisherman fishes throughout the year, not just during the summer months. He knows when different animals are "in season" and takes advantage of this knowledge.

Comparison with other Special Forest Products Extraction

Many people have a misconception that non-Anglo ethnic groups use natural resources for purely commercial or subsistence purposes. This is not the case with Puerto

Rican fishermen. A recent study with many parallels to Puerto Rican fishing concerned fern extraction by Asian-Americans in the San Bernardino National Forest (Anderson et al 2000). This research shows that, contrary to common perception, extraction was not occurring primarily for commercial use.

As with the fern-gatherers, fishing is primarily a consequence of social and environmental factors. These include spending time with friends or family who share this hobby, being in a familiar environment, and enjoying the activity. The whole process from extracting the resource to taking it home and using it is socioculturally important. As with the Asian fern-pickers, most Puerto Ricans consider fishing to be fun, not work.

The overriding evidence that special forest product use is a cultural activity and not commercial is that people do not sell their product. Of the fishermen surveyed, only one said that he sells any of his catch. Most fishermen talked about how they cook them and when and where they eat them.

Education and Management

As with recreationists, increased education of fishermen is important. However, due to their small numbers and relatively small impact on the aquatic system, it is not as crucial to target this specific user group. Fishermen who do not visit recreation sites along the river would be the most difficult to contact. Fishermen education concerning aspects of river use that are most critical to healthy wildlife populations could be improved, including the reproduction cycle of diadromous animals and the importance of throwing back gravid females. They should understand that by following these guidelines, they would be ensuring healthy wildlife populations for the future.

Fishermen should also learn more about the effects of chemicals like Clorox on the animals they catch and on the entire aquatic system. They should be aware that damaging the river for short-term gain could have harmful effects far into the future. This affects not only the ecology of the system, but also the ability of humans to us a desired resource. Managers should consider fishermen opinions when creating fishing policies and should then ensure that fishermen are aware of these policies.

Conclusion

While it is still unclear how much fishing actually occurs along the Espiritu Santo and Mameyes Rivers, this study indicates that fishermen populations are relatively small and most likely do not have a significant impact on aquatic fauna. Most fishermen are out on the river to enjoy themselves and to be alone or with a small group of friends. The animals they catch are an important part of the activity, but they are not a vital food source. For some fishermen the activity carries a stronger traditional meaning, but they still do not depend on the animals for food.

In general, fishermen were relatively knowledgeable about the area they were fishing in. However, there are a few areas in which education could improve. A notable number of fishermen stated that there are less large shrimp and fish in the rivers than there used to be. There could be many reasons for this, including other anthropogenic influences on the aquatic system, and this should be considered by river managers in order to ensure a sustainable aquatic ecosystem. In order to gain a better understanding of this unique group of river users, a more extensive study should be conducted.

Conclusion

Recreational use of the streams and rivers of the Puerto Rican rainforest plays an important role in sustainability of this ecosystem. Current research of recreational use of the forest remains limited and is principally confined to tourist use. Another important group of recreationists exists along the Mameyes and Espiritu Santo rivers. These people are almost exclusively local Puerto Ricans and they show definite patterns of river use and knowledge of the ecology of the system they recreate in. Fishermen are a special sub-population of river users whose effects should also be more fully researched. Information provided by these people can aid management decisions and help ensure healthier and more sustainable systems in the future.

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